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Question 1 – Perspective Projection:

We want to express $\tilde{x}_w$ using x, z and f. We can see that $\tilde{x}_w$ is crossing 2 lines. We will find these lines and extract $\tilde{x}_w$.

The first line goes through the points $(0,0)$ and (z', x'). So, to find the line we can write:

$$m_1 = \frac{x_2 - x_1}{z_2 - z_1} = \frac{x' - 0}{z' - 0} = \frac{x}{z} \rightarrow \left(from\ point\ (0,0)\right) \rightarrow 0 = 0 * \left(\frac{x'}{z'}\right) + b \rightarrow b = 0$$

$$x = mz + b \rightarrow \boldsymbol{x = \frac{x'}{z'} * z}$$

For the second line we know it goes through point $(-f, 0)$ and have $90 - \theta$ angle with z axis. $(m_z = 0)$

First, we find m_2:

$$\tan(90 - \theta) = \frac{m_2 - m_z}{1 + m_z * m_2} = m_2$$

Now we find the line equation:

$$x - x_0 = m_2(z - z_0) \rightarrow x - 0 = \tan(90 - \theta)\,(z + f)$$

$$\boldsymbol{x = (z + f)\tan(90 - \theta)}$$

Now we combine the two equations:

$$\frac{x'}{z'} * z = (z + f)\tan(90 - \theta)$$

$$\frac{x'}{z'} * z = (\tan(90 - \theta)\, z + \tan(90 - \theta)\, f)$$

$$\frac{x'}{z'} * z - \tan(90 - \theta)\, z = \tan(90 - \theta)\, f$$

$$z\left(\frac{x'}{z'} - \tan(90 - \theta)\right) = \tan(90 - \theta)\, f$$

$$z = \frac{\tan(90 - \theta)\, f}{\frac{x'}{z'} - \tan(90 - \theta)}$$

Now we just need to write

$$\tilde{x}_w = \frac{x'}{z'} * z = \frac{x'}{z'} * \frac{\tan(90 - \theta)\, f}{\frac{x'}{z'} - \tan(90 - \theta)}$$

Question 2G:

There is a problem with this approach because the pictures he took from the internet have been taken by different cameras. so, the calculation of the camera matrix and the distortion coefficients will not be accurate.

Question 3 – Reading Material:

Section A:

According to Dawkins, the dilemma that the evolution had to solve is the size of the hole in the eye that light goes through.

If the pinhole is too large than "the eye is seeing too much". every point in the world sends rays to every point on the retina, so infinite number of images are clashing and the picture we get is blurry.

Otherwise, if the pinhole is too small, we need a massive amount of light to see the object. But at normal lighting levels not enough photons get through the pinhole for the picture to be clear so we get a dark image.

There is a trade-off between sharp & dark image to bright & fuzzy one. The solution is the lens that bending the rays, so we get more light rays, but they directed to specific point on the retina so the image we get is sharp & bright.

Section B:

In our opinion, computer vision scientists should not attempt to emulate human vision.

We do believe that scientists should learn about the human vision but not emulate it.

The reason is that "the evolution took its course under a set of physical constraints that are substantially different from the technological barriers that confront us today".
Furthermore, the human vision has its flaws: "The fallibility of the human visual system is amply demonstrated by the existence of visual illusions."

"Humans may "see" what is not (i.e., hallucinate) and they may not "see" what is (i.e., overlook)."

In addition, our knowledge about human vision, and how the brain processes the information is Insufficient. "What is known about the human visual system beyond the human eye is largely disjointed, speculative, and meager".

Section C:

ccd	**cmos**
Relatively Noise free	Higher noise – each pixel has an amplifier
Requires a lot of electricity	Low power requirements
Read out is slow	Parallel processing allows faster image capture
Images recorded in a single instance	Record data line by line

Section D:

האובייקט שבחרנו לייצג בשתי דרכים - הוראות הגעה לכתובת מסוימת.

מצד אחד, אפשר לייצג זאת על ידי רשימה של פניות שעל הנהג לבצע. המידע שבא במקרה זה לידי ביטוי בצורה הברורה ביותר הוא הפניות שעל הנהג לבצע ואילו המיקום הגאוגרפי של היעד הסופי לא ברור.

מצד שני, אפשר לייצג את הוראות ההגעה בעזרת דרך מסומנת על גבי מפה. לפי שיטה זו, קל לנהג לדעת מיקום גיאוגרפי של היעד ובאילו אזורים עוברת הדרך. אך מצד שני, על מנת לא לפספס פניות, הנהג יצטרך להתאמץ באופן יחסי. כי מידע זה לא מונגש וברור מספיק.